

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL MEMORANDUM

No. 1193

MEASUREMENTS ON COMPRESSOR-BLADE LATTICES

By F. Weinig and B. Eckert

Translation of

“Messungen an Schaufelgittern für Verdichter”
Berichte der Gittertagung in Braunschweig
Institut für Motorenforschung der
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At the end of 1940 an investigation of a guide-vane lattice for the compressor of a TL unit [NACA comment: Turbojet] was requested. The greatest possible Mach number had to be attained.

The investigation was conducted with an annular lattice subjected to axial flow.

A direct-current shunt motor with a useful output of 235 horsepower at an engine speed of 1800 rpm was available for driving the necessary blower. In designing the blower the speed was set at 10,000 rpm. A gear box from an armored car was used as gearing in which supplementary fresh oil lubrication was installed. The gear box was used to step up from low to high speeds.

The blower that was designed is two stage. The hub-tip ratios v are 0.79 to 0.82; the design pressure coefficient ψ for each stage is 0.6 and the design flow coefficient ϕ is 0.4. The rotor diameter D_a is 0.39 meters and the resulting peripheral speed is $u_a = 204$ meters per second [NACA comment: Value corrected from the German]. The blower was entirely satisfactory. The construction of the test stand is shown in figure 1. The air flows in through an annular inlet, which is used in the measurement of the quantity of air, and is deflected into an inward-pointing radial slot. A spiral motion is imparted to the air by a guide-vane installation manually adjustable as desired, which enables injection of the air, after it has been deflected from the radial direction to the axial direction, into the lattice being investigated at any desired angle.

Streamers are installed upstream and downstream of the lattice under investigation to indicate the direction of flow. After the

*"Messungen an Schaufelgittern für Verdichter." Berichte der Gittertagung in Braunschweig, Institut für Motorenforschung der Luftfahrtforschungsanstalt Hermann Göring, März 27 u. 28, 1944.

air leaves the lattice, a part of the kinetic energy is converted into pressure in an annular diffuser, and the air then passes on through the blower and is finally vented radially outward through an annular slot opening. The width of the annular slot may be adjusted as desired, in order to serve as the necessary throttling device. A view of the test stand as constructed is shown in figure 2. The construction of the measuring section proper is shown in figure 3. The guide-vane lattice is so mounted as to be radially and longitudinally movable. The turning moment produced is transmitted by a lever arm and the axial thrust is transmitted by the axle and a lever to a pair of inclination balances.

The annular lattice that was investigated is shown in figure 4. The diameter at the blade ends $D_a = 220$ millimeters; the radial dimension of the blades $b = 30$ millimeters.

At low velocities, the velocity distribution over the annular test section is very good upstream and downstream of the test lattice because of the pronounced acceleration upstream of the test section but the distribution is not as satisfactory at higher velocities although always satisfactory enough for the intended purpose.

Axial velocities as high as $c_m = 250$ meters per second were attained in the annular space containing the blades.

As derived from the observed data, figure 5 shows the lift coefficient as a function of the angle of attack α for several Mach numbers. [NACA comment: The change in the type of line in the upper portion of these curves seems to be incorrect. In addition, the sudden increase in slope for the upper curves is questionable.] The polar curves obtained are shown in figure 6.

Because of a change in the plans of the requesting organization, the experiments were discontinued at the end of July 1942 shortly after the test stand was ready for use.

The test stand proved to be very suitable for the experiments conducted. If further experiments were to be conducted with an altered stagger of the lattice, however, changing the annular space, which in the region of the test lattice has been cylindrical, into an annular space of spherical shape might be desirable.

DISCUSSION

In the discussion it was pointed out that the influence of the boundary layers along the inner and the outer walls of the tunnel

must be considerable because of the short radial length of the blades in the lattice under investigation. This influence was of no importance for the purpose for which the measurements described were carried out; however, for basic investigations of blade lattices use of substantially longer blade lengths would presumably be necessary. This increase in blade length would, however, markedly increase the expense of investigating annular lattices. The expense is much less for measurements on a two-dimensional lattice but offsetting that advantage there is always the question of how far the results of two-dimensional experiments can be applied to the bladings in an axial machine.

Translation by Edward S. Shafer,
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for Aeronautics.

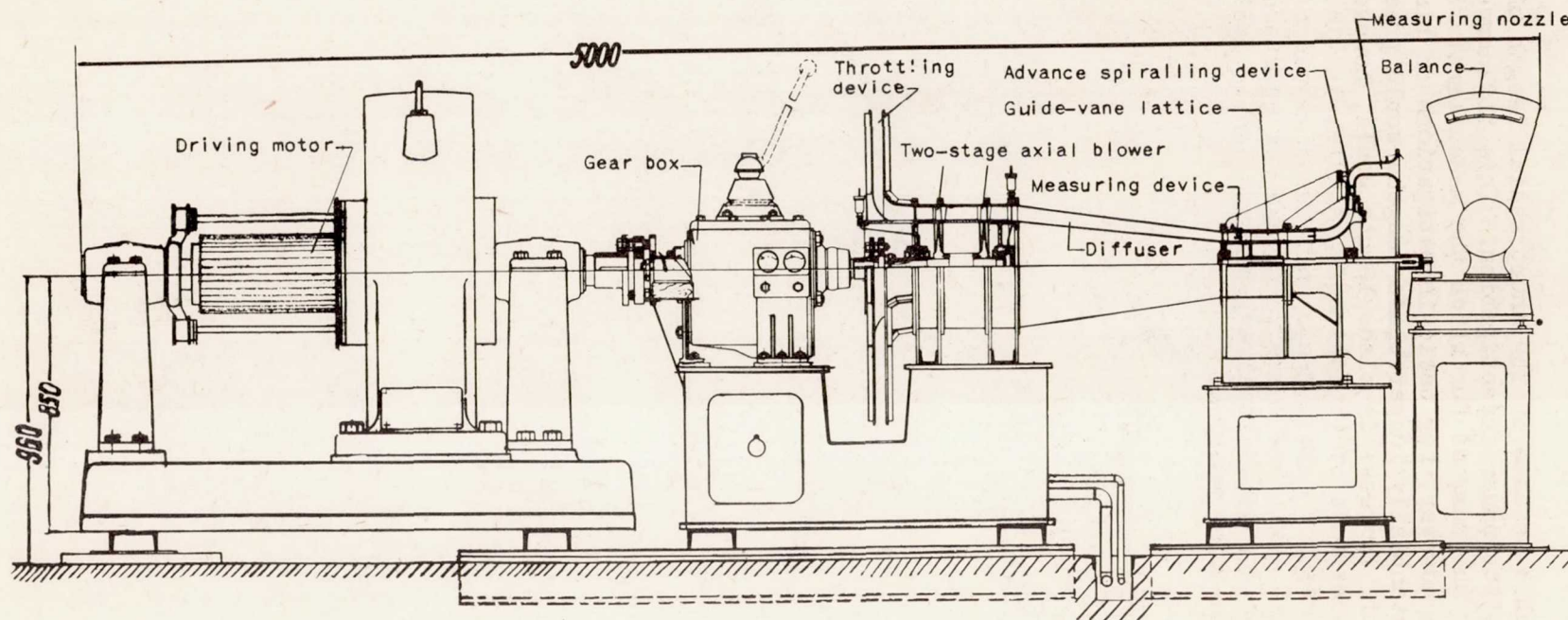


Figure 1.

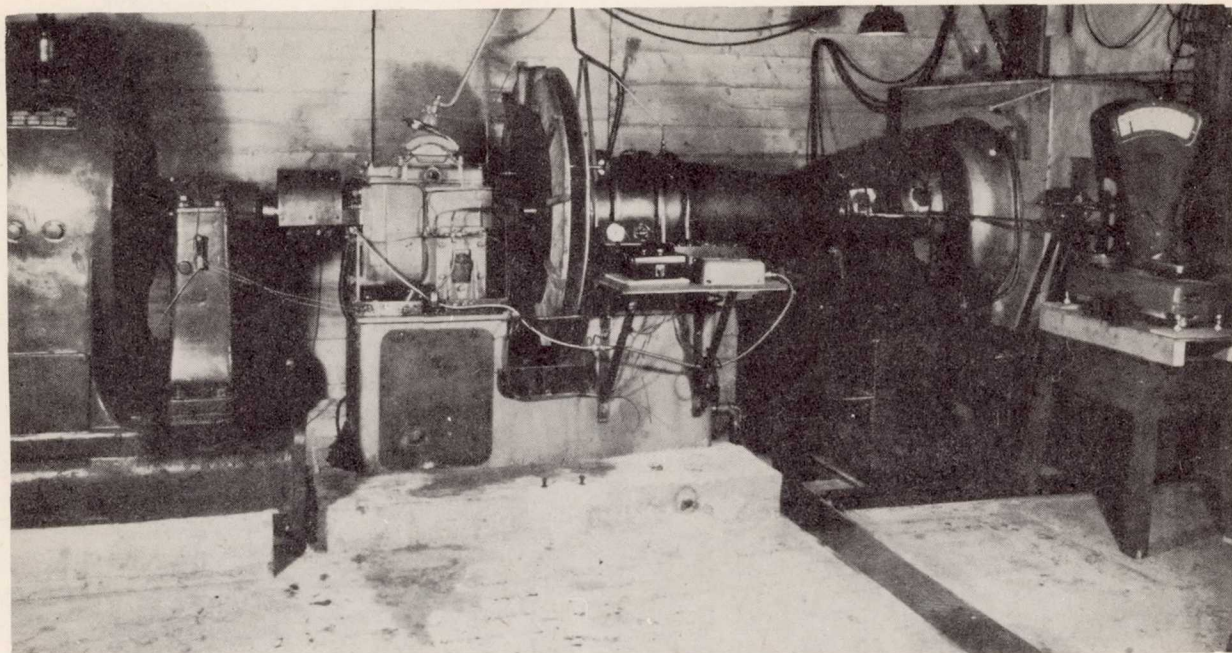


Figure 2.

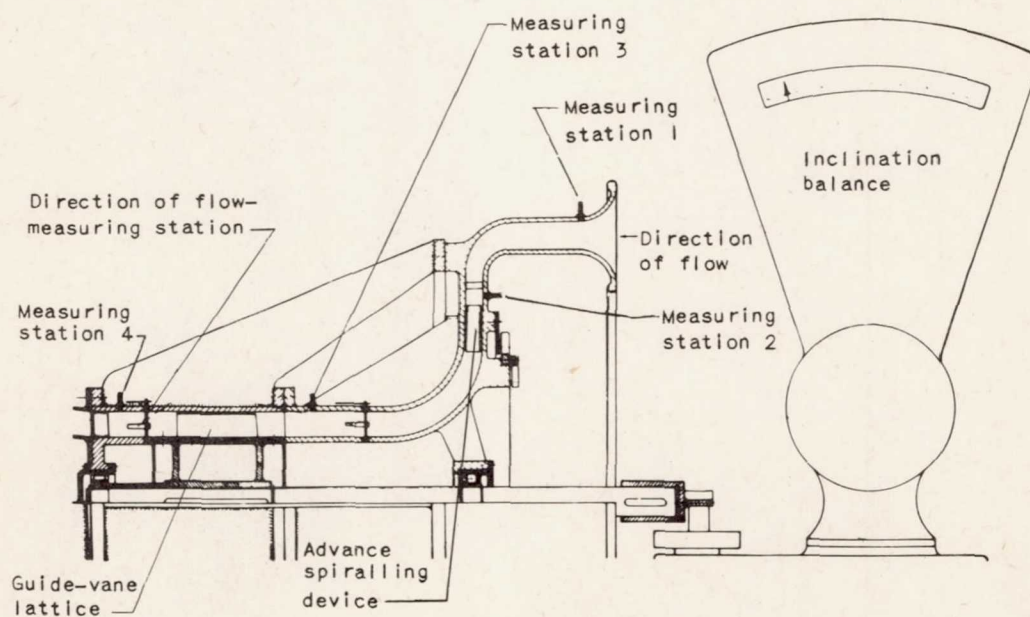


Figure 3. - Arrangement of pressure-measurement stations on lattice test stand.

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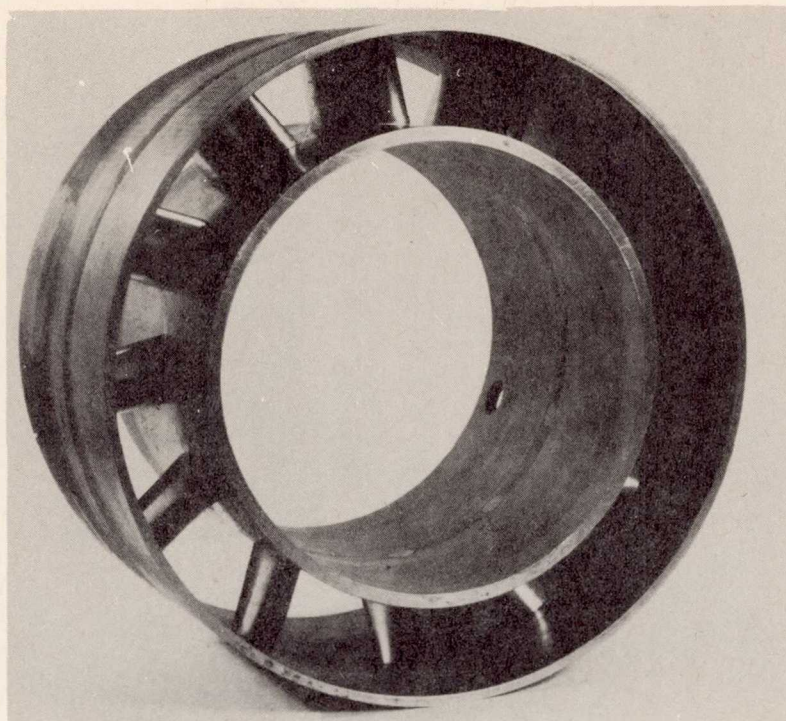


Figure 4.

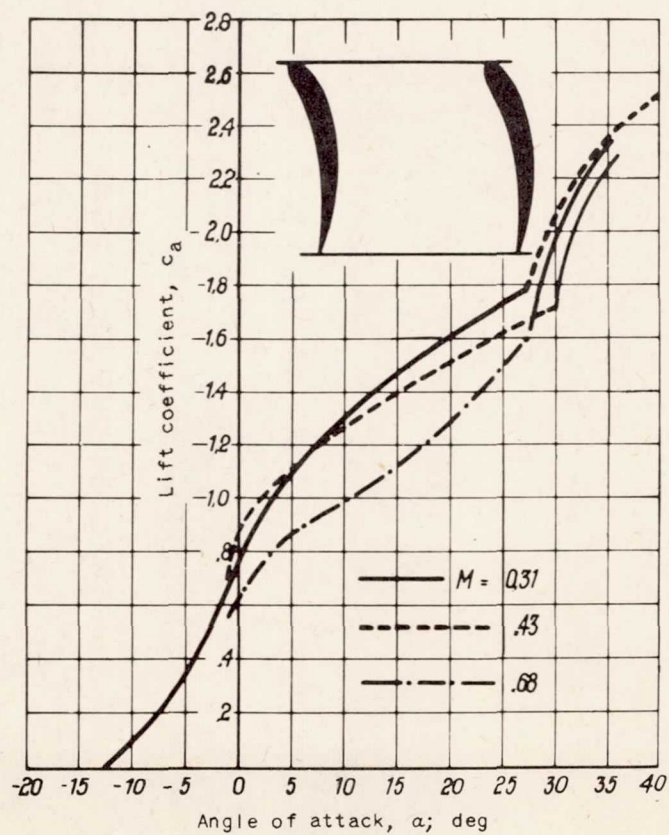


Figure 5.

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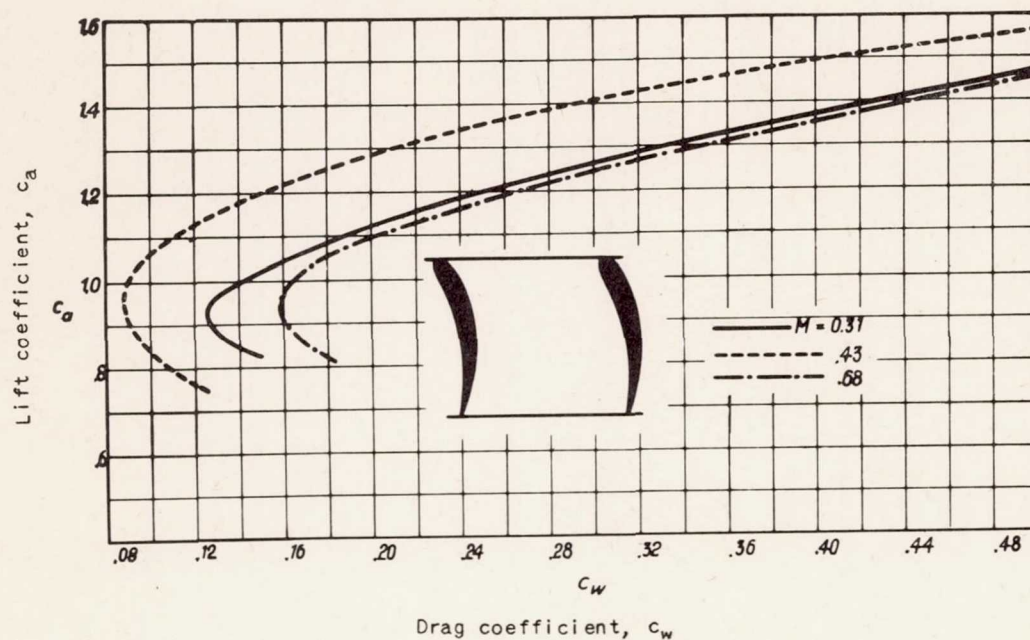


Figure 6.